10 FIRE DEBRIS

10.1 Introduction to Petroleum Products

10.1.1 Objectives

Through completion of this module the trainee will develop the theoretical knowledge to be conversant in:

- History of petroleum products;
- Composition of various petroleum fractions; and,
- Manufacturing processes of petroleum distillates and the end use of products.

10.1.2 Required Readings

10.1.2.1 Dehaan, J. D., Kirk's Fire Investigation, 4th Ed., Upper Saddle River, NJ, Prentice-Hall, Inc., 1997, pp. 7-17.

10.1.2.2 Dolan, J. A., "Refinery Operations for the Fire Debris Chemist" Workshop notes from MAAFS, April 24, 2001.

10.1.2.3 Fultz, M. L. and Dehaan, J. D., "Gas Chromatography in arson and explosives analysis", Chapter 5, pp. 109-117.

10.1.2.4 Mann, D. C., "Comparison of Automotive Gasolines Using Capillary Gas Chromatography I: Comparison Methodology." *Journal of Forensic Sciences*, Vol. 32, No. 3, May 1987, pp. 606-615.

10.1.2.5 Mann, D. C., "Comparison of Automotive Gasolines Using Capillary Gas Chromatography II: Limitations of Automotive Gasoline Comparisons in Casework," *Journal of Forensic Sciences*, Vol. 32, No. 3, May 1987, pp. 616-628.

10.1.2.6 Speight, J. G. The Chemistry and Technology of Petroleum, New York, M. Decker, 1980, pp. 423-462.

10.1.3 Questions

The trainee will provide written answers to the following questions:

- Briefly explain how petroleum crude oil is formed.
- What are the major processes for the manufacturing of petroleum products?
- What types of hydrocarbons are present in petroleum products?
- What are the petroleum products identified by DFS?
- Describe the differences between the DFS and the ASTM classes of petroleum products.
- What does the octane level of gasoline refer to?
- Is it possible to determine the brand name of a gasoline sample? Common source?
- What are pristane and phytane? What petroleum product(s) can they be found in?
- How do manufacturing processes affect the identification of petroleum products?
- Define paraffinic.

10.1.4 Evaluation

10.1.4.1 The trainer will review the written answers to the questions with the trainee.

1.5.4.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.1.4.3 The trainee will be quizzed orally of the subject matter.

10.2 Introduction to Fire and Arson Investigation

10.2.1 Objectives

Through completion of this module the trainee will develop the theoretical knowledge to be conversant in:

- Arson and accelerant terminology;
- General knowledge of fire scene investigations; and,
- Proper techniques in recovery, collection, preservation and packaging of fire debris evidence.

10.2.2 Required Readings

10.2.2.1 Bowen, J. E., "Phenomenon of Spontaneous Ignition is Still Misunderstood by Some" Fire Engineering, May 1982, pp. 23-24.

10.2.2.2 Dehaan, J. D., Kirk's Fire Investigation, 4th Ed. Upper Saddle River, NJ, Prentice-Hall, Inc., 1997, pp. 1-6, 18-284, 315-327, 394-418.

10.2.2.3 Mann, D. C., "In Search of the Perfect Container for Fire Debris Evidence" Fire & Arson Investigator, April 2000, pp. 21-25.

10.2.3 Questions

The trainee will provide written answers to the following questions:

- What is an accelerant?
- Explain the four essential components necessary for a fire to occur.
- What is combustion?
- Define
    - Autoignition
    - Backdraft
    - Combustible
    - Flammable
    - Conduction
    - Convection
    - Fire
    - Fire Load
    - Flame Point
    - Flash point
        - What are the methods to determine flash point?
        - What are the limiting factors?
    - Overhaul
    - Pyrolysis
    - Point of Origin
    - Pyromania
    - Spontaneous ignition
    - Pour pattern
    - Trailers
    - Volatile
- What are some considerations that should be made prior to the collection of evidence?
    - Where should samples be taken from if there is a pour pattern?
    - Is carpet or concrete a better sample? Why?

- What are the advantages and disadvantages to packaging evidence with; metal cans, K-pak bags, paper and glass jars?
- What packaging materials are preferred by DFS and why?

10.2.4 Evaluation

10.2.4.1 The trainer will review the written answers to the questions with the trainee.

10.2.4.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.2.4.3 The trainee will be quizzed orally upon the subject matter.

10.3 Turpentine and Terpenes

10.3.1 Objectives

Through completion of this module the trainee will develop the theoretical knowledge to be conversant in:

- Manufacturing processes of turpentine
- Composition of soft woods v. turpentines

10.3.2 Required Readings

10.3.2.1 Trimpe, M. A., "Turpentine in Arson Analysis," Journal of Forensic Sciences, Vol. 36, No. 4, July 1991, pp. 1059-1073.

10.3.2.1 Zinkel, D. F., Organic Chemicals from Biomass, Chapter 9 "Turpentine, Rosin, and Fatty Acids from Conifers", I.S. Goldstein, Ed. CRC Press, Boca Raton, FL. 1981, pp. 163-187.

10.3.3 Questions

The trainee will provide written answers to the following questions:

- What is turpentine?
- How is turpentine made?
- Under what circumstances could turpentine be identified?
- List the most common Terpenes seen in soft wood extracts.

10.3.4 Evaluation

10.3.4.1 The trainer will review the written answers to the questions with the trainee.

10.3.4.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.3.4.3 The trainee will be quizzed orally upon the subject matter.

10.4 Initiating Devices

10.4.1 Objectives

Through completion of this module the trainee will develop the theoretical knowledge to be conversant in:

- Pyrotechnic/incendiary devices and initiating reactions (IID's – Improvised Incendiary Devices); and,

- General (very basic) knowledge of explosives and their possible relationships to fire and arson investigations.

10.4.2 Required Readings

10.4.2.1 Dehaan, J. D., Kirk's Fire Investigation, 4th Ed., Upper Saddle River, NJ, Prentice-Hall, Inc., 1997, pp. 285-335.

10.4.3 Questions

The trainee will provide written answers to the following questions:

- What are some common devices used for starting fires?
- Where can the materials for the devices be obtained?
- What is a Molotov cocktail?
- Define incendiary device.
- Define explosive device.
- Define deflagration.
- Define detonation.
- Which metals are highly reactive (flammable)?
- What are the components of matches?
- What is the most widely used initiating device in arson?

10.4.4 Evaluation

10.4.4.1 The trainer will review the written answers to the questions with the trainee.

10.4.4.2 The trainer and trainee will review and discuss the pertinent points of each of the required readings.

10.4.4.3 The trainee will be quizzed orally on the subject matter.

10.5 Evaluation and Characterization of Debris

10.5.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Understand the effect that the substrate/debris can have on the identification of petroleum products.

10.5.2 Required Readings

10.5.2.1 Cherry, C., "Arsonist's Shoes: Clue or Confusion?," Illinois State Police, copy of presentation.

10.5.2.2 Lentini, J. J, et al. "The Petroleum-Laced Background" presentation notes.

10.5.2.3 Mann, D. C. and Gresham, W. R., "Microbial Degradation of Gasoline in Soil," Journal of Forensic Sciences, Vol. 35, No. 4, July 1990, pp. 913-923.

10.5.2.4 Tranthim-Fryer, D. J. and DeHaan, J.D., "Canine accelerant detectors and problems with carpet pyrolysis products", Science & Justice, 1997, Vol. 37, pp. 39-46.

10.5.3 Questions

The trainee will provide written answers to the following questions:

- What are some types of material that can give a "petroleum laced background"?
- Why can soil be problematic? What steps can be taken to minimize these effects?
- What steps can be taken to minimize these background effects?
- Why should the soles of shoes be avoided as samples, if possible?
- What types of petroleum products may be encountered in inked paper products?
- What types of petroleum products may be encountered in leather goods?
- What are some pyrolysis products that may be encountered when extracting plastic and/or synthetic materials?
- What are some pyrolysis products that may be encountered when extracting wood and/or organic materials?
- What are some pyrolysis products that may be encountered when extracting clothing?
- Does a positive reaction by an accelerant detection canine or a hydrocarbon detector indicate that a petroleum product is present? Explain.

10.5.4 Practical Exercises

10.5.4.1 Extraction and evaluation of various debris samples is to be done in conjunction with the practical exercises in Section 10.7.

10.5.5 Evaluation

10.5.5.1 The trainer will review the written answers to the questions with the trainee.

10.5.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.5.5.3 The trainee will be quizzed orally upon the subject matter.

10.6 Instrumental Methods – Gas Chromatography

10.6.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Understand and describe gas chromatography; and,
- Describe and demonstrate the application of gas chromatography to the identification of petroleum products.

10.6.2 Required Readings

10.6.2.1 ASTM E 1387-95 "Standard Test Method for Ignitable Liquid Residues in Extracts for Fire Debris Samples by Gas Chromatography".

10.6.2.2 Bertch, W., "Analysis of Accelerants in Fire Debris – Data Interpretation" Forensic Science Review, Vol. 9, No. 1, June 1997, pp. 1-8.

10.6.2.3 Fultz, M. L. and Dehaan, J. D., "Gas Chromatography in arson and explosives analysis", Tebbett, I., ed., Gas Chromatography in Forensic Science, Ellis Horwood Limited, England, 1992, pp. 117-135.

10.6.2.4 Rood, D., A Practical Guide to the Care, Maintenance, and Troubleshooting of Capillary Gas Chromatography Systems, New York, NY, Wiley-VCH, 1999.

10.6.3 Questions

The trainee will provide written answers to the following questions:

- What are the chromatographic conditions that are used by DFS for the analysis of fire debris?
- Why is the stationary phase used a good choice for petroleum products?
- What are the chromatographic conditions used for headspace screening?
- Why are the headspace conditions different from the fire debris conditions?
- In what order do nonpolar compounds separate on a nonpolar column?
- Would you expect polar compounds to be retained on a nonpolar column?

10.6.4 Practical Exercises

10.6.4.1 The trainee will successfully complete the gas chromatography section of the training manual.

10.6.4.2 Known samples (direct injection):

Obtain and directly inject, as a minimum, the following products:

- Whole gasoline
- 99R gasoline
- 50R kerosene
- Whole diesel fuel
- 50R diesel fuel
- Penn Champ Lighter Fuel
- Lone Star Paint Thinner
- Whole Coleman Fuel
- Heritage Lamp Oil
- Mr. Bar-B-Q charcoal lighter fluid

10.6.5 Evaluation

10.6.5.1 The trainer will review written answers to the questions with the trainee.

10.6.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.6.5.3 Review of practical exercises to include a discussion regarding major pattern differences, weathering, and overlap.

10.7 Extraction Methods

10.7.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Perform current extraction techniques to include headspace, solvent, dynamic and passive adsorption/elution; and,
- Determine which extraction procedure to use under varying sample conditions.

10.7.2 Required Readings

10.7.2.1 ASTM E 1388-00 “Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples”.

10.7.2.2 ASTM E 1412-00 “Standard Practice for Separation and Concentration of Ignitable Liquid Residues from fire Debris samples by Passive Headspace Concentration”.

10.7.2.3 ASTM E 1413-00 "Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Dynamic Headspace Concentration".

10.7.2.4 Buckleton, J. S., Bettany, B. L. and Walsh, K. A. J., "A Problem of Hydrocarbon Profile Modification by Charcoal," *Journal of Forensic Sciences,* Vol. 34, No. 2, March 1989, pp. 449-453.

10.7.2.5 Demers-Kohls, J. F., et. al., "Evaluation of the DFLEX Device for Fire Debris Analysis," *Can. Soc. Forens. Sci. J.*, Vol. 27, No. 3, 1994, pp. 99-123.

10.7.2.6 Dietz, W. R., "Improved Charcoal Packaging for Accelerant Recovery by Passive Diffusion," *Journal of Forensic Sciences*, Vol. 36, No. 1, January 1991, pp. 111-121.

10.7.2.7 Lentini, J. J. and Armstrong, A. T., "Comparison of the Eluting Efficiency of Carbon Disulfide with Diethyl Ether: The Case for Laboratory Safety," *Journal of Forensic Sciences*, Vol. 42, No. 2, 1997, pp. 307-311.

10.7.2.8 Newman, R. T., Dietz, W. R. and Lothridge, K., "The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion, Part I: The Effects of Time, Temperature, Strip Size, and Sample Concentration," *Journal of Forensic Sciences*, Vol. 41, No. 3, May 1996, pp. 167-176.

10.7.2.9 Phelps, J. L., Chasteen, C. E., and Render, M. M., "Extraction and Analysis of Low Molecular Weight Alcohols and Acetone from Fire Debris Using Passive Headspace Concentration," *Journal of Forensic Sciences,* Vol. 39, No. 1, January 1994, pp. 194-206.

10.7.2.10 Sandercock, P. M. L., "Comparison of Passive Charcoal Adsorption with a Dynamic Charcoal Adsorption Technique," *Can. Soc. Forens. Sci. J.*, Vol. 27, No. 3, 1994, pp. 179-201.

10.7.2.11 Smith, C. B. and Macy, J., "Methods of Fire Debris Preparation for Detection of Accelerants," *Forensic Science Review,* Vol. 3, No. 1, June 1991, pp. 58-69.

10.7.2.12 Waters, L. V. and Palmer, L. A. "Multiple Analysis of Fire Debris Samples Using Passive Headspace Concentration," *Journal of Forensic Sciences*, Vol. 38, No. 1, January 1993, pp. 165-183.

10.7.3 Questions

The trainee will provide written answers to the following questions:

- Define adsorption, absorption, adsorbent, adsorbate, adsorbed phase.
- What are the two basic types of adsorption that occur? Which occurs with the use of active carbon?
- What are the two basic types of desorption? Which is used for active charcoal, and why?
- Define displacement and breakthrough. Is the literature clear concerning the difference between the two terms?
- What problems in recovery can occur if ambient temperatures are used for the extraction process?
- What problems in recovery can occur if extraction temperatures are too high?
- Discuss the factors that can lead to distorted recovery (discuss both skewing toward the light ends as well as toward the heavy ends) and how these factors can be minimized.
- Explain the distortions that can occur among classes of compounds when strong samples are extracted.
- What additional steps must be added to the standard passive headspace concentration extraction for petroleum products if detection of alcohols and/or low molecular weight oxygenated solvents is disired?
- Can kerosene and fuel oil #2/diesel fuel-type products be differentiated when passive headspace concentration is the method of extraction? Explain.
- Define and give examples of competitive adsorption.
- Suggest a flow chart for fire debris analysis incorporating passive headspace concentration.

- Under what circumstances would dynamic headspace concentration be preferred over passive headspace concentration? What are the advantages and disadvantages of each?
- Under what circumstances would water be added to the debris before extraction? How much water is appropriate?
- Describe the use of steam distillation and vacuum distillation for the extraction of petroleum products from debris. Why are these no longer preferred methods?
- Why is ambient headspace analysis not a preferred method for the identification of petroleum products?
- Describe solvent extraction.
- Why is pentane used for solvent extraction at DFS?
- Under what conditions is solvent extraction preferred over adsorption/elution extractions?
- How can you determine if a whole sample liquid is aqueous or nonaqueous?

10.7.4 Practical Exercises

10.7.4.1 The trainee will be given a group of 10 liquids, each composed of 4mL of pentane and 1 drop of a petroleum product. The trainee will treat these unknowns as if they are separate case extracts. A pattern is to be obtained for each and printed at appropriate attenuations to show the pattern, front and back ends. The trainee will run appropriate standards and write the results as they would appear on a report.

10.7.4.2 The trainer will discuss with the trainee how to take appropriate notes, how to properly use worksheets and what abbreviations are in standard use for paint analysis.

10.7.4.3 The trainee will receive a set of unknown samples consisting of debris and a sample of a petroleum product. These samples will be solvent (pentane) extracted and run on a GC-FID. Appropriate standards are to be run and the results written as they would appear on a report.

10.7.4.4 The trainee will receive a set of unknown samples consisting of debris and a sample of a petroleum product. These samples will be dynamic adsorption/elution (charcoal tube) extracted and run on a GC-FID. Appropriate standards are to be run and the results written as they would appear on a report.

10.7.4.5 The trainee will receive a set of unknown samples consisting of debris and a sample of a petroleum product. These samples will be passive adsorption/elution (charcoal strip) extracted and run on a GC-FID. Appropriate standards are to be run and the results written as they would appear on a report.

10.7.4.6 A set of unknown samples will be extracted by ambient headspace in conjunction with the practical exercises for GC-MS.

10.7.5 Evaluation

10.7.5.1 The trainer will review written answers to the questions with the trainee.

10.7.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.7.5.3 Review of practical exercises to include a comparison of the extraction techniques and the appropriateness of each.

10.8 Instrumental Methods – GC-MS

10.8.1 Objectives

Through completion of this module the trainee will have developed and demonstrated theoretical knowledge and/or practical skills to:

- Understand and describe gas chromatography – mass spectrometry (GC-MS);
- Describe and demonstrate the application of GC-MS to the identification of petroleum products;
- Understand and explain ion-profiling and its application to fire debris analysis; and,
- Identify volatile compounds in the headspace of samples.

10.8.2 Required Readings

10.8.2.1 ASTM E1618-97 "Standard Guide for Identification of Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry".

10.8.2.2 Bertch, W., "Analysis of Accelerants in Fire Debris – Data Interpretation" *Forensic Science Review*, Vol. 9, No. 1, June 1997, pp. 8-22.

10.8.2.3 Nowicki, J., "An Accelerant Classification Scheme Based on Analysis by Gas Chromatography/Mass Spectrometry (GC-MS)" *Journal of Forensic Sciences*, Vol. 35, No. 5, Sept. 1990, pp. 1064-1086.

10.8.2.4 Wallace, J. R., "GC/MS Data from Fire Debris Samples: Interpretation and Applications" *Journal of Forensic Sciences*, Vol. 44, No. 5, 1999, pp. 996-1012.

10.8.3 Questions

The trainee will provide written answers to the following questions:

- What is a TIC?
- What is ion profiling?
- Describe the difference between ion profiling and selected ion monitoring.
- What are the ion profiles used for petroleum products? Why are they chosen?
- What are the predominant ion profiles for each class of petroleum products?
- Can mixtures of different petroleum products be resolved using ion profiling? Explain.

10.8.4 Practical Exercises

10.8.4.1 The trainee will successfully complete the gas chromatography –mass spectrometry section of the training manual.

10.8.4.2 The trainee will directly inject known petroleum products; one from each class as a minimum. The data will be displayed using the standard ion profiling macro.

10.8.4.3 The trainer will select extraction samples from previous practical exercises for injection and ion profiling.

10.8.4.4 The trainee will receive a set of unknown samples consisting of debris and a sample of a volatile component. These samples will not be opened. They will be headspace extracted and run on the GC-FID with polar column. After appropriate standards are run, the samples and standards will be run on the GC-MS to identify any volatile compounds present.

10.8.4.5 The trainee will receive a set of unknown samples consisting of debris and a sample of a petroleum product. These samples will be extracted by a method chosen by the trainee and run on a GC-FID. The sample extracts shall also be run on a GC-MS and extracted ion profiled. Appropriate standards are to be run and the results written as they would appear on a report.

10.8.5 Evaluation

10.8.5.1 The trainer will review written answers to the questions with the trainee.

10.8.5.2 The trainer and the trainee will review and discuss the pertinent points of each of the required readings.

10.8.5.3 Review of practical exercises.

10.9 Supervised Casework

The trainee will work at least twenty forensic cases as a technician for a qualified fire debris examiner. The trainer should ensure as much variety in the casework as is practicable.

10.10 Forensic Significance of Fire Debris Analysis

The trainer and the trainee will discuss the interpretation of fire debris evidence and its relevance and weight in reports and in testimony. Discussions will include identifying a class of products versus individual identification of a commercial product.

10.11 Report Writing

The trainer will review and discuss with the trainee the standard report wording in Section 6.10 of the Trace Evidence Standard Operating Procedures.

The trainer will provide ten cases previously examined by other qualified fire debris examiners for the trainee to review and discuss with the trainer.

The trainee will draft report wording as a part of the analysis of their training sets as well as when performing supervised casework.

Report writing will be evaluated throughout the training period by the trainer.

10.12 Fire Debris Presentation and Oral Examination

The trainee will prepare a presentation of approximately 20-30 minutes in length which they will present to a group consisting of qualified fire debris examiners, the QA Coordinator, as available, and any Director that chooses to attend. The presentation may cover either: the general theory and application of GC and GC-MS in fire debris analysis; the forensic examination of fire debris; or a current topic that has been approved by the Section Chief that is of interest to the forensic fire debris community.

The trainee will field questions regarding their presentation topic as well as questions related to any/all aspects of their fire debris training.

10.13 Competency Evaluation and Mock Trial

10.13.1 As the trainee progresses through fire debris training, they will begin to process training sets as they would for casework to include drafting a Certificate of Analysis. There will be a minimum of three of these “case” files completed prior to issuance of the final competency test.

10.13.2 Using one or all of the “cases” from 10.13.1, the trainee will undergo a series of “mini-mock trial” practice sessions with qualified examiners from the Trace Evidence Section. It may be useful to include practice sessions with examiners from Sections other than Trace Evidence.

10.13.3 The trainee will be provided with a final competency test for analysis. This test will mimic actual casework to the maximum extent possible and will include at least one sample requiring headspace analysis and identification, at least one sample positive for petroleum products and at least one sample negative for petroleum products.

The trainee will analyze the final competency test samples and issue a Certificate of Analysis based upon their findings. The trainee will be called upon to defend their results via testimony in a formal mock trial setting. The mock trial will typically be scheduled about two weeks after the fire debris presentation and oral examination.

10.13.4 The trainer and the trainee will review the mock trial video tape in a timely fashion.

10.14 Certification

Upon successful completion of the training process, following Section 15.6 of the Division of Forensic Science, Quality Manual, the trainee will be issued a written certification memorandum.

10.15 Reading List

10.15.1 ASTM E 1387-95 "Standard Test Method for Ignitable Liquid Residues in Extracts for Fire Debris Samples by Gas Chromatography".

10.15.2 ASTM E 1388-00 "Standard Practice for Sampling of Headspace Vapors from Fire Debris Samples".

10.15.3 ASTM E 1412-00 "Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration".

10.15.4 ASTM E 1413-00 "Standard Practice for Separation and Concentration of Ignitable Liquid Residues from Fire Debris Samples by Dynamic Headspace Concentration".

10.15.5 ASTM E1618-97 "Standard Guide for Identification of Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry".

10.15.6 Bertch, W., "Analysis of Accelerants in Fire Debris – Data Interpretation" *Forensic Science Review*, Vol. 9, No. 1, June 1997.

10.15.7 Bowen, J. E., "Phenomenon of Spontaneous Ignition is Still Misunderstood by Some" *Fire Engineering*, May 1982, pp. 23-24.

10.15.8 Buckleton, J. S., Bettany, B. L. and Walsh, K. A. J., "A Problem of Hydrocarbon Profile Modification by Charcoal," *Journal of Forensic Sciences*, Vol. 34, No. 2, March 1989, pp. 449-453.

10.15.9 Cherry, C., "Arsonist's Shoes: Clue or Confusion?," Illinois State Police, copy of presentation.

10.15.10 DeHaan, J. D., Kirk's Fire Investigation, 4th Ed. Upper Saddle River, NJ, Prentice-Hall, Inc., 1997.

10.15.11 Demers-Kohls, J. F., et. al.. "Evaluation of the DFLEX Device for Fire Debris Analysis," *Can. Soc. Forens. Sci. J.*, Vol. 27, No. 3, 1994, pp. 99-123.

10.15.12 Dietz, W. R., "Improved Charcoal Packaging for Accelerant Recovery by Passive Diffusion," *Journal of Forensic Sciences*, Vol. 36, No. 1, January 1991, pp. 111-121.

10.15.13 Dolan, J. A., "Refinery Operations for the Fire Debris Chemist" Workshop notes from MAAFS, April 24, 2001.

10.15.14 Lentini, J. J, et al. "The Petroleum-Laced Background" presentation notes.

10.15.15 Lentini, J. J. and Armstrong, A. T., "Comparison of the Eluting efficiency of Carbon Disulfide with Diethyl Ether: The Case for Laboratory Safety," *Journal of Forensic Sciences*, Vol. 42, No. 2, 1997, pp. 307-311.

10.15.16 Mann, D. C., "Comparison of Automotive Gasolines Using Capillary Gas Chromatography I: Comparison Methodology." *Journal of Forensic Sciences*, Vol. 32, No. 3, May 1987, pp. 606-615.

10.15.17 Mann, D. C., "Comparison of Automotive Gasolines Using Capillary Gas Chromatography II: Limitations of Automotive Gasoline Comparisons in Casework," *Journal of Forensic Sciences*, Vol. 32, No. 3, May 1987, pp. 616-628.

10.15.18 Mann, D. C., "In Search of the Perfect Container for Fire Debris Evidence" *Fire & Arson Investigator*, April 2000, pp. 21-25.

10.15.19 Mann, D. C. and Gresham, W. R., "Microbial Degradation of Gasoline in Soil," Journal of Forensic Sciences, Vol. 35, No. 4, July 1990, pp. 913-923.

10.15.20 Newman, R. T., Dietz, W. R. and Lothridge, K., "The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion, Part I: The Effects of Time, Temperature, Strip Size, and Sample Concentration," *Journal of Forensic Sciences*, Vol. 41, No. 3, May 1996, pp. 167-176.

10.15.21 Nowicki, J., "An Accelerant Classification Scheme Based on Analysis by Gas Chromatography/Mass Spectrometry (GC-MS)" *Journal of Forensic Sciences*, Vol. 35, No. 5, Sept. 1990, pp. 1064-1086.

10.15.22 Phelps, J. L., Chasteen, C. E., and Render, M. M., "Extraction and Analysis of Low Molecular Weight Alcohols and Acetone from Fire Debris Using Passive Headspace Concentration," *Journal of Forensic Sciences*, Vol. 39, No. 1, January 1994, pp. 194-206.

10.15.23 Rood, D., A Practical Guide to the Care, Maintenance, and Troubleshooting of Capillary Gas Chromatography Systems, New York, NY, Wiley-VCH, 1999.

10.15.24 Sandercock, P. M. L., "Comparison of Passive Charcoal Adsorption with a Dynamic Charcoal Adsorption Technique," *Can. Soc. Forens. Sci. J.*, Vol. 27, No. 3, 1994, pp. 179-201.

10.15.25 Smith, C. B. and Macy, J., "Methods of Fire Debris Preparation for Detection of Accelerants," *Forensic Science Review*, Vol. 3, No. 1, June 1991, pp. 58-69.

10.15.26 Speight, J. G. The Chemistry and Technology of Petroleum, New York, M. Decker, 1980, pp. 423-462.

10.15.27 Tebbett, I., ed., Gas Chromatography in Forensic Science, Ellis Horwood Limited, England, 1992.

10.15.28 Tranthim-Fryer, D. J. and Dehaan, J. D., "Canine accelerant detectors and problems with carpet pyrolysis products" *Science & Justice*, Vol. 37, 1997, pp. 39-46.

10.15.29 Trimpe, M. A., "Turpentine in Arson Analysis," Journal of Forensic Sciences, Vol. 36, No. 4, July 1991, pp. 1059-1073.

10.15.30 Wallace, J. R., "GC/MS Data from Fire Debris Samples: Interpretation and Applications" *Journal of Forensic Sciences*, Vol. 44, No. 5, 1999, pp. 996-1012.

10.15.31 Waters, L. V. and Palmer, L. A. "Multiple Analysis of Fire Debris Samples Using Passive Headspace Concentration," *Journal of Forensic Sciences*, Vol. 38, No. 1, January 1993, pp. 165-183.

10.15.32 Zinkel, D. F., Organic Chemicals from Biomass, Chapter 9 "Turpentine, Rosin, and Fatty Acids from Conifers", I.S. Goldstein, Ed. CRC Press, Boca Raton, FL. 1981, pp. 163-187.

◄End